AI-ENABLED CLOUD COMPUTING AS A DRIVER OF OPERATIONAL EFFICIENCY IN THE DIGITAL ECONOMY

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Abstract: *The article analyzes the role of AI-enabled cloud computing in improving operational efficiency in the digital economy. Based on the dissertation materials devoted to cloud computing efficiency, the study focuses on the integration of artificial intelligence with IaaS, PaaS, SaaS and hybrid cloud models. The paper proposes an AI-Cloud Efficiency Framework that links workload prediction, automatic scaling, anomaly detection, cost optimization, decision support and security readiness. A mathematical model, workflow diagram and analytical comparison table are presented. The results show that the integration of artificial intelligence and cloud services can improve resource utilization, accelerate managerial decisions, reduce operational costs and support safer digital transformation. At the same time, the model emphasizes the need to manage information security, provider dependency and shortage of qualified specialists.*

Keywords: *artificial intelligence, cloud computing, digital economy, AI-cloud integration, operational efficiency, resource optimization, hybrid cloud, decision support, information security.*

INTRODUCTION

The digital economy is increasingly based on data-driven services, remote access to information resources and rapid processing of large volumes of information. In such an environment, traditional IT infrastructure often becomes insufficient because it requires high capital expenditure, local maintenance, long deployment cycles and limited scalability. Cloud computing has therefore become one of the most important technological platforms for organizations that seek flexible infrastructure and faster digital transformation.

Cloud technologies provide computing resources, storage, platforms and software services through the internet. They allow organizations to use IaaS, PaaS, SaaS and hybrid deployment models according to their economic and technical needs. However, the efficiency of cloud computing is not determined only by the availability of virtual resources. Real efficiency depends on how these resources are managed, monitored and adapted to changing workload conditions.

Artificial intelligence can significantly strengthen the value of cloud computing. AI algorithms can forecast resource demand, detect abnormal activity, optimize virtual machines, recommend cost-saving actions and support managerial decision-making. For this reason, AI-cloud integration is becoming a strategic direction for enterprises, educational institutions, healthcare organizations, public services and digital business platforms.

The purpose of this article is to develop an AI-enabled model for assessing and improving the operational efficiency of cloud computing services in the digital economy.

The study is based on the idea that cloud infrastructure should be evaluated not only through cost indicators, but also through automation, service availability, decision speed, data security and risk management.

2. Related Work and Research Gap

Cloud computing is commonly described through three main service models: Infrastructure as a Service, Platform as a Service and Software as a Service. These models provide different levels of control and responsibility. IaaS gives organizations flexible virtual infrastructure, PaaS supports software development and deployment, while SaaS provides ready-to-use applications. In practice, many organizations combine public and private resources in a hybrid cloud model to balance flexibility, security and cost control.

Previous studies emphasize that cloud computing can reduce infrastructure costs, support remote work, increase service availability and accelerate the launch of digital products. The dissertation materials used in this study also indicate that cloud services are important for shifting enterprises from rigid capital expenditure to flexible operational expenditure and for evaluating economic efficiency through TCO and ROI indicators.

Nevertheless, many cloud efficiency assessments remain cost-oriented. They often compare only subscription cost, server cost or migration cost. Such an approach does not fully explain the operational value of AI-based cloud management. The research gap addressed in this paper is the need for a compact framework that connects cloud service models with artificial intelligence functions and operational efficiency indicators.

3. Proposed AI-Cloud Efficiency Framework

The proposed AI-Cloud Efficiency Framework includes four interacting layers. The first layer collects enterprise workloads, system logs, user activity data and business requirements. The second layer represents the cloud platform, including IaaS, PaaS, SaaS and hybrid cloud governance. The third layer applies artificial intelligence functions such as workload prediction, auto-scaling, anomaly detection, cost optimization and decision support. The fourth layer produces efficiency indicators for managers: lower total cost, faster decision-making, better resource utilization and controlled operational risk.

In this framework, AI is not considered as a separate module added after cloud migration. It is treated as a management mechanism that continuously analyzes cloud behavior and recommends practical actions. For example, if user demand increases during a specific period, the prediction module can recommend temporary resource scaling. If resource usage decreases, the system can reduce unnecessary virtual machines and prevent overpayment. If abnormal network behavior appears, anomaly detection can warn the administrator before the incident becomes critical.

The proposed framework is especially useful for organizations that operate in conditions of unstable demand. Educational platforms, medical information systems, online payment services, e-commerce systems and public service portals may experience different workload levels during the day or academic year. AI-enabled cloud management allows such organizations to avoid both underutilization and resource shortage.

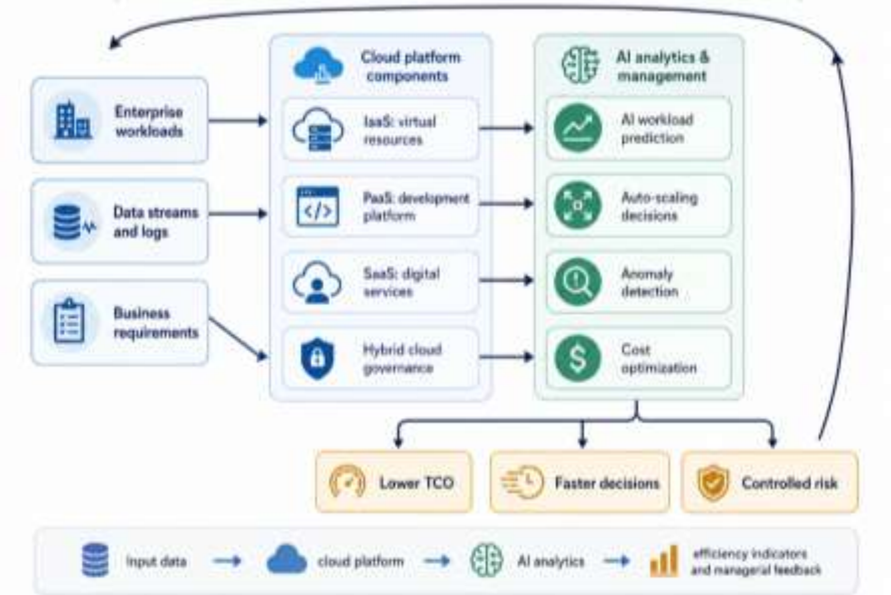

Figure 1. AI-enabled cloud computing efficiency framework

4. Mathematical Model of AI-Cloud Efficiency

The cost-saving effect of cloud computing can be calculated by comparing traditional infrastructure costs with optimized cloud service costs:

CS = ((Ctrad - Ccloud) / Ctrad) * 100% (1)

Here, CS is the cost-saving percentage, Ctrad is the cost of traditional IT infrastructure and Ccloud is the total cost of cloud services after migration and optimization.

The AI-based resource utilization coefficient is calculated as follows:

RUai = Uactive / Uallocated (2)

In Eq. (2), Uactive represents actually used computing resources and Uallocated represents the total allocated resources. A higher RUai value indicates that allocated resources are being used more efficiently. AI-based monitoring can increase this coefficient by reducing idle servers and adapting resources to demand.

To combine economic, technical and managerial indicators, the integrated AI-cloud efficiency index is proposed:

ICE = w1*CS + w2*RUai + w3*SA + w4*DS + w5*SR - w6*OR (3)

In Eq. (3), ICE is the integrated cloud efficiency index, CS is cost saving, RUai is AI-based resource utilization, SA is service availability, DS is decision speed, SR is security readiness and OR is operational risk. Coefficients w1...w6 define the importance of each indicator for a particular organization. The model allows decision-makers to compare different cloud management strategies using a single normalized efficiency score.

5. Analytical Evaluation and Discussion

A scenario-based analytical evaluation was prepared to demonstrate the practical logic of the proposed model. Four scenarios were compared: traditional cloud services without advanced analytics, monitored cloud services, AI-enabled cloud services and AI-enabled hybrid cloud architecture. The comparison uses relative indicators because the exact values may differ depending on organization size, workload type, security policy and provider conditions.

Table 1. Analytical comparison of AI-cloud efficiency scenarios

Scenario	Cost optimization	Resource utilization	Decision speed	Security readiness	Efficiency index
Traditional cloud	Medium	0.61	0.58	0.60	0.62
Monitored cloud	Good	0.72	0.70	0.68	0.73
AI-enabled cloud	High	0.86	0.88	0.82	0.86
AI-enabled hybrid cloud	High	0.89	0.91	0.88	0.90

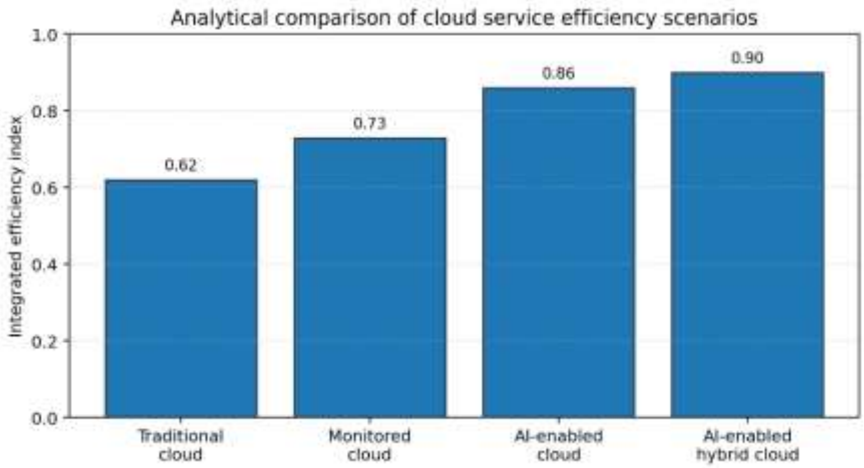

Figure 2. Analytical comparison of cloud service efficiency scenarios

The analytical comparison shows that AI-enabled cloud services can improve resource utilization and decision speed compared with ordinary cloud deployment. In the traditional cloud scenario, organizations can receive remote resources, but they still depend heavily on manual configuration and periodic monitoring. The monitored cloud scenario is more efficient because it uses dashboards and alerts; however, decisions are still made mainly by administrators.

The AI-enabled cloud scenario improves efficiency because prediction and optimization are performed continuously. It can automatically recommend scaling, identify unused resources and provide earlier warnings about abnormal activity. The AI-enabled hybrid cloud scenario shows the highest index because it combines intelligent optimization with stronger control over sensitive data. This is important for organizations that work with personal, financial, educational or medical data.

At the same time, the discussion should not ignore the risks of AI-cloud integration. The dissertation materials note that cloud services may face information security risks, high computing resource demand and a shortage of qualified specialists. Therefore, AI-enabled cloud transformation must be supported by cybersecurity policy, staff training, provider selection criteria and clear responsibility for data governance.

6. Scientific Novelty and Practical Value

The scientific novelty of this article is that it proposes a combined AI-cloud efficiency model that evaluates cloud computing not only through cost reduction, but also through resource utilization, service availability, decision speed, security readiness and operational risk. The model connects artificial intelligence functions with practical cloud management tasks and converts them into measurable efficiency indicators.

The practical value of the proposed framework is that it can be used before and after cloud migration. Before migration, it helps compare possible scenarios and select the most appropriate cloud model. After migration, it can be used as a monitoring and optimization tool. The model is suitable for medium and large enterprises, educational organizations, healthcare institutions and public digital platforms that need scalable and secure digital infrastructure.

7. Conclusion

This article analyzed AI-enabled cloud computing as a driver of operational efficiency in the digital economy. The proposed AI-Cloud Efficiency Framework combines enterprise workloads, cloud service models, artificial intelligence functions and managerial efficiency indicators into a single decision-oriented structure. The mathematical model includes cost saving, AI-based resource utilization and an integrated efficiency index.

The analytical evaluation shows that the integration of AI and cloud computing can increase resource efficiency, accelerate decision-making and strengthen risk control. However, successful implementation requires security readiness, qualified specialists, continuous monitoring and a well-designed governance policy. Future research should test the model using real enterprise datasets and develop a software module that automatically calculates the integrated AI-cloud efficiency index for different organizations.

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